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Research Paper

Economic Analysis of Value Added Product Vacuum Fried Carrot Chips

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ABSTRACT

Vacuum frying is a promising technology for preparation of snacks which fulfill the consumers demand and meet nutritious requirements. The vacuum frying process was carried out in a closed system, the samples were fried under vacuum condition (< 6 kPa). Due to low pressure, the boiling point of the oil and water in the food was reduced. Besides these advantages, the vacuum fried oil can be reused efficiently for several times without alter the oil quality thus enhancing its economic feasibility. The vacuum frying technology was used for the preparation of carrot chips. The carrot strips were subjected to vacuum fryer had the temperature of 100 °C, pressure of 13 kpa and time of 11 min. The objective of the research was to estimate the cost of one kg of vacuum fried carrot chips including variable and fixed costs. The Cost economics and Benefit cost ratio of the VF carrot chips was determined by using the standard procedure. The cost economics for the production of vacuum fried carrot chips was estimated as ₹ 355/- per kg and benefit cost ratio was found to be 3.38:1.

HIGHLIGHTS

- Vacuum frying is a promising technology for preparation of snacks which fulfill the consumers demand and meet nutritious requirements.
- The cost economics for the production of vacuum fried carrot chips was estimated as ₹ 355/- per kg which was low compared to industrial vacuum fried products.
- The benefit cost ratio was found to be 3.38:1.

Keywords: Vacuum frying, Carrot chips, Cost analysis and Benefit cost ratio

Carrot (*Daucus carota* L.) is one of the most important cool season root crop vegetable cultivated in tropical region as well as temperate regions during winter and summer season, respectively (Raees-ul and Prasad, 2015). During the last 30 years, world-wide carrot production was significantly increased. Carrots are moderately hard, long and thin, cylindrical or spherical in shape (Alam *et al.* 2018). The most usually eaten part of a carrot is the taproot, which contains high levels of β-carotene (pre-vitamin A) and carbohydrates (sugars). Now-a-days, orange color carrots become very popular due to the presence of pro-vitamin-A content and high amount of α and β-carotene. Carrot recorded the highest amount of carotene content of any human foods. Carrot contains vitamins *viz.*, B1 (Thiamine), B2 (Riboflavin), B6 (Niacin) and B12 (Cobalamin) besides rich in source of β-carotene and dietary fibres which are helpful to prevent cancer and other dreadful diseases occur in human body. 100 g fresh

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carrot contains 8285 μg of β-carotene and 2.8 g of dietary fibres, which are beneficial to human health.

The post-harvest losses of carrot was noted as 15-20%. Carrot is a seasonal crop and perishable. Due to seasonal variations the price of carrots varies. The preparation of value-added products from carrot is an idealistic solution to reduce the post-harvest loss when it is available in plenty with less price especially during the glut season. The value-added products obtained from the carrots were pickles, chips, canned slices, juice, concentrate, preserve, cake, *halwa*, strips, flakes intermediate moisture foods, dehydrated, and various types of ready to serve beverages such as flavoured carrot juice and blended beverage.

The processing of the carrot with new technologies was became popular, which were good taste and market. The vacuum frying technology was selected for the preparation of carrot chips, as it is produced and marketed on large scale at jurisdiction of Kelappaji College of Agricultural Engineering and Technology, Tavanur, Kerala. Vacuum frying is a promising technology for preparation of snacks which fulfill the consumers demand and meet nutritious requirements (Dueik *et al.* 2010). Vacuum frying is new technology (Ranaselva, 2017) which uses a very low pressure and temperature rather than atmospheric deep fat frying to improve the quality attributes of food products. In vacuum frying the food is heated at very low pressure (less than 6 kPa). At such reduced pressures, the boiling point as well as smoke point of oil gets reduced. The absence of air during the frying process inhibits oxidation including lipid oxidation and enzymatic browning and thus could retain color and flavor. Vacuum frying offers a minimal change in oil quality and desired organoleptic properties without loss in nutritional value. Besides these advantages, the vacuum fried oil can be reused efficiently for several times without alter the oil quality thus enhancing its economic feasibility. The main aim of the present research study was to estimate the production and cost analysis of vacuum fried carrot chips

MATERIALS AND METHODS

The research work was carried out at the Dept of Processing and Food Engineering (P&FE), Kelappaji College of Agricultural Engineering and Technology, Tavanur, Kerala.

Preparation of vacuum fried carrot chips: The orange colour and matured carrot was procured from the local market at Tavanur, Kerala. Carrots were cleaned manually, peeled with peeler and made into strips by using Dicer. The average thickness and diameter carrot strips were less than 4 mm and 39.07 mm respectively.

Description of machine

The research was conducted using a vacuum frying system available in the Department of Processing and Food Engineering, KCAET, Tavanur. Vacuum fryer was a batch type, having a capacity of 3 kg. The system consisted of two chambers namely frying chamber and oil storage chamber. The two chambers were made up of stainless steel (SS 316). The frying chamber and oil storage chamber was provided with heaters - two heaters in frying chamber and one in oil storage chamber, respectively. The water ring vacuum pump, cooling tower, compressor, nitrogen cylinder and condenser were also attached to the vacuum frying system. The entire system was controlled by a microprocessor and PID (Proportional Integral Derivative) controller. A de-oiling system was mounted inside the frying chamber with frying basket holder (Ranasalva, 2017). The specifications of vacuum frying system was displayed in Table 1.

Vacuum frying (Batch type vacuum fryer with 35L oil capacity)

The vacuum frying process involved in different steps *viz.*, sample loading, frying/heating oil, depressurization, frying and de-oiling, pressurization and cooling (Garayo and Moreira, 2002; Ranasalva N, 2017).

Initially the samples were weighed and filled in the frying baskets. The two frying baskets were filled with equal amount (approx. 1050-1100 g each) of samples in order to maintain the balance during de-oiling. The carrot samples were fried in 35L of RPO under processing conditions of frying temperature (100ºC), pressure (13 kPa) and time (25 min). Quality evaluation of the used oil was conducted after every batch of vacuum frying. After frying, the product was centrifuged at 1000 rpm for 6 min.

Table 1: Specifications of Vacuum frying system (KCAET, Tavanur, Kerala)

Sl. No.	Particulars	Specifications
1	Capacity	3 kg Batch Type
2	No. of Baskets	02
3	No. of Chamber	1. Frying Chamber 2. Oil storage Chamber
4	No. of Heaters	Three Heaters 1. Two in Frying chamber 2. One in Oil storage Chamber
5	De-oiling system	0.5 hp Motor; 1000 rpm
6	Vacuum Pump	2 hp motor having the capacity of 30 m^3/kg
7	Compound dial gauge type	(-1 to 4 kg/cm^2)
8	Pressure transmitter	0 to 250 kPa
9	Cooling system	1 hp motor with 10L Capacity cooling tower
10	Compressor	—
11	Nitrogen cylinder	—
12	Stainless Steel	SS 316

Economic evaluation of developed vacuum fried carrot chips

The cost of vacuum fried chips was calculated on the basis of initial cost of raw material(carrot and oil), fabrication cost of machinery, wages of operator, etc. Annual use of vacuum frying machine was considered as 2200 h. Total cost of operation of the for preparation of chips was determined on per hour basis considering both fixed and variable costs (Pokharkar *et al.* 2017). Fixed cost includes depreciation, interest, insurance, taxes and housing of machine. The variable cost includes electricity charges, labour charges, repair and maintenance. The total cost of production of one kg vacuum fried carrot chips was calculated by the sum of fixed and variable cost with effective field capacity of the machine. Straight line method of cost estimation was followed in economic evaluation of the machine.

Mathematical formulas for calculations of cost analysis (Pooja M.R. 2018)

Fixed Costs

1. Depreciation per year = $\frac{C-S}{L\times H}$
2. Interest per year = $\frac{C+S}{2}\times\frac{i}{H}$
3. Tax, Housing and insurance per year = $C\times\frac{Y}{100}$

Where – Initial cost of Machine – C

Expected life of Machine (L) = 10 years

Working hour (H) = 2200 h/year, working hours is 8 h/day @ 275 days

Salvage value (S) = 10 per cent of capital cost

Rate of interest (i) = 10 per cent per annual

Y = 2 per cent of capital cost

Variable cost: (Reddy V.K. & Kumar, P. 2010)

1. Repair & maintenance, (₹/h) = $\frac{C}{H}\times\frac{R}{100}$; R = 5% of Initial cost
2. Electricity cost

(a) Energy consumed by the vacuum fryer

Cost of energy consumption/h = power × duration × cost of 1 unit

(b) Energy consumed by slicer, cooling tray and packaging machine

Cost of energy consumption/h = power × duration × cost of 1 unit

3. Labour cost
4. Packaging cost
5. Skilled assistants
6. Manager

Cost analysis

For commercialization of the optimized vacuum fried product, the cost economics was done. The cost economics was determined by standard method with necessary assumptions. The variable costs and fixed costs were determined.

RESULTS AND DISCUSSION

Cost economics for developed vacuum fried carrot chips

The raw carrot of *Ooty-1* variety was selected for the development of the vacuum fried carrot chips. Carrots were cleaned manually, peeled with peeler and made into strips by using Dicer. The carrot strips were subjected to vacuum fryer had the temperature of 100, pressure of 13 kpa and time of 11 min. By operating the system manually, the carrot chips were fried and the oil stored in the chips were removed by using centrifugation of 1000 rpm at 5 min. The fried chips were subject to Cooling and then packed in LDPE packing material with 95 % nitrogen gas and then stored at room temperature.

Estimation of cost of production for vacuum fried carrot chips

For estimating the cost of production of VF Chips, we have to consider all the equipments cost which was used for the experiment. The following results as follows:

Cost of machineries and building		Rupees /-
Cost of vacuum frying machine	=	10,00,000
Cost of slicer	=	50,000
Cost of cooling chamber	=	1,00,000
Cost of packaging machine	=	30,000
Building cost (2000 sq.ft) @ 1500/ sq.ft	=	30,00,000
Miscellaneous items	=	1,00,000
Total cost	=	**43,00,000**
Assumptions		
Life Span (L)	=	10 years
Annual Working Hours (H)	=	275 days (per 8 hrs)
	=	2200 hrs
Salvage Value (S)	=	10% of initial cost
Interest on Initial Cost (I)	=	10 % annually
Repair and Maintenance	=	5 % initial cost
Insurances and Taxes	=	2 % of initial cost
Electricity Charges	=	₹ 8/- per unit
Labour Wages/Person (5 Ns/₹ 500/ Day)	=	₹ 2500/-
Skilled Assistants (2 Ns/750/Day)	=	₹ 1500/-
One Manager (@ 900 / Day)	=	₹ 900/-

1. **Fixed Costs**

(a) **Depreciation** =

$$\frac{C-S}{L\times H}=\frac{43,00,000-4,230,000}{10\times 2200}$$

= ₹ 176/- per hour

(b) **Interest** =

$$\frac{C+H}{2}\times\frac{i}{H}=\frac{4230000+423000}{2}\times\frac{15}{100\times 2200}$$

= ₹ 161/- per hour

(c) **Insurances & Taxes** = 2 % initial cost

$$\frac{2}{100\times 2200}\times 43,00,000$$

= ₹ 39/- per hour

Total cost = a + b + c = 176 + 161 + 39 = ₹ 376/- per hour

2. **Variable costs**

(i) **Repair and maintenance** = 5 % of initial cost

$$\frac{5}{100\times 2200}\times 21,50,000$$

= ₹ 49/- per hour

(ii) **Electricity cost**

Energy consumed by the vacuum fryer = 30kw/h

Cost of energy consumption/h = power × duration × cost of 1 unit

= 30× 8 × 8 = ₹ 1920 /- per hour

Energy consumed by slicer, cooling tray and packaging machine = 2 kw/h

Cost of energy consumption/h = power × duration × cost of 1 unit

= 2 × 8 × 8 = ₹ 128/- per hour

(iii) Labour cost (5 persons @ ₹ 500) = ₹ 2500/day = ₹ 312.5/- per hour

(iv) Packaging cost = ₹ 3000/- per day = ₹ 375/- per hour

(v) Skilled assistants (2 persons @ ₹ 750) = ₹ 1500/- = ₹ 187.5/- per hour

(vi) Manager = ₹ 900/day = ₹ 112.5/- per hour

(vii) Cost of raw material for preparation of vacuumed fried carrot chips

Sl. No.	Raw materials	Quantity (kg)	Unit rate (per kg)	Total amount (₹)
1	Carrot	1200	40	48000
2	Frying oil	200	100	20000
	Total			**68000**

Therefore variable cost (carrot chips) = 49 + 1920 + 128 + 312.5 + 375 + 187.5 + 112.5 + 68000

= ₹ 77,967 / day

(For 3 kg basket capacity of raw chips, we get 0.5 kg of vacuum fried chips)

Therefore total cost of production of 200 kg vacuum fried carrot chips

= Fixed cost + Variable cost

= 376 + 71084

= ₹ 77,967 /200 kg of VF- carrot chips

For 1 kg of vacuum fried chips = ₹ 355/ kg of vacuum fried carrot chips.

The market selling price 1kg of vacuum fried carrot chips is ₹ 1200 kg

$$\text{Benefit-cost ratio} = \frac{1200}{355} = 3.38$$

The benefit- cost ratio for the production of vacuum fried carrot chips was found to be 3.38:1.

Life and annual utility of machine were taken as 10 years and 2200 hours per year respectively. Operational cost of the machine was taken as ₹ 376/-and variable cost was taken as ₹ 71084/-. The cost economics for the production of one kg vacuum fried carrot chips was estimated as ₹ 355/- per kg and benefit cost ratio was found to be 3.38:1.

CONCLUSION

The present research showed the estimation analysis of value-added product namely vacuum fried carrot chips. Cost analysis was calculated based on standard procedures and assumptions. The fixed cost and variable cost of the VF chips was ₹ 376/- and ₹ 71084/- respectively. The cost economics for the production of one kg vacuum fried carrot chips was estimated as ₹ 355/- per kg and benefit cost ratio was found to be 3.83:1. The study was concluded that there is an increasing trend for snack food item with good taste, flavour, crispness and low oil content with low cost and everyone likes the product.

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